Sustainability in Construction Industry - The Bamboo Potential

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Abstract

The construction industry has long resulted in damage to the environment both during construction and demolition. There is hardly any regulation or policy to regulate the damage caused during and after the construction process. Most construction research focuses on other factors and leaves out sustainability as a distant second in priority. Both steel and cement are the major offenders when it comes to usage of natural resources. The bamboo perfectly fits in here as both a low cost construction material and rural livelihood provider at the same time. Being a hardy plant species, this solution is easy to put into action.

Keywords:

Bamboo, construction, concrete, steel, sustainability, carbon dioxide, oxygen, rural economy, pollution, recycling

Damage caused by construction

Most research focuses on damage caused to buildings and other infrastructure constructions. Very few study the damage caused by the constructions on the environment and natural resources. Aigbavboa (2017) has listed out the damage caused by the construction industry in South Africa. He mentions wastes generated during the construction process, intensive use of energy, huge usage of water, and general damage to air, water and soil. One of the major causes of rise in construction activity is the increase in population exponentially due to reduced mortality due to better medical facilities, better nutrition and increased health awareness across the globe. Added to this, the major driver of economic growth has always been related to a growth in the construction industry, be it housing, infrastructure, schools, research institutions and anything in general related to buildings. While this is a positive development, it has had a huge backlash in terms of unsustainable growth in construction activity across the world with very little concern of awareness about sustainability norms and designs in construction.

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The governments too seem more preoccupied with the current economic growth and do not dedicate much time or efforts towards judging the environmental impact of the ventures and the general depleting effect it has on supplies of water, steel and landscape. Sustainable construction is not given a high priority in policy making circles. Mehra et al(2022) have elaborated the damage in more detail. They mention diminishing of resources, increased carbon dioxide emissions, and a predominant focus on steel and cement industries.They go on to propose a link between the construction and related industries with tsunamis, floods, bushfires, general sea level rise, depletion of the ozone layer and also the contamination of soil leading to destruction of soil life. Steel contributes to emission of carbon dioxide in the manufacturing process, transporting process. Same is the case with cement as well. Iron and steel is the biggest energy consumer in the world and a bulk of this industry supplies the construction industry. Abyareh et al (2019) mention the specific damage caused by the steel industry. Their list includes soil contamination, a bulk of which happens to be heavy metals. Conejo et al (2020) have pointed out the role of steel plants in generation of huge amounts of waste water which is rarely recycled for other productive uses. Not to mention the huge mining costs and associated damage to the environment by creating deep holes, damaged soil due to heavy machine usage, and all extraction related losses. Bao et al (2020) mention that recycling construction waste is a huge problem and they are best processed in situ. This is rarely done as government support is not forthcoming and recycling equipment is also not available at hand. This leads to further polluting the environment as this waste has to be sent to a landfill. The value chain of construction therefore is ending in a blind alley without much analysis of the final consequences of demolition waste disposal. Its a linear supply chain that does not replenish the raw materials and nor does it get the finished product disposal back into the economy and as such is an unsustainable process.

Jain et al (2020) suggest that recycling is a better option as regards sustainability when compared to sending the debrii to the landfill.

Jain et al (2021) guess that the construction and demolition wastes account for 2-8% of natural resources used in the construction industry and hence need to be recycled. But the whole problem is the lack of a proper recycling technology for construction demolition wastes. And surprisingly the contribution of rural areas to this waste outweighs the urban waste generated due to the sheer size of the area under consideration.

Ramanathan and Ram (2020) note that since construction and demolition wastes are less hazardous when compared to other industries, they have been overlooked, leading to lack of standards for dumping and management of recycling initiatives. Added to this the estimates of

this waste is not accurate enough to take appropriate action. The major method of dealing with these wastes is to reduce the size, recover the aggregates and create recycled products like paver blocks, ready mix concrete and other precast products. Makegaonkar and Dange (2018) proposes that 60% of the construction and demolition wastes can be recycled. But this leaves out 40% of the generated wastes causing a huge stress on the ecosystem. The above discussions lead us to propose that

H1: Current construction materials are not designed for easy recycling or reuse. The materials needs additional investment to turn it into a usable form and that too only a fraction of the total wastes.

H2: A drastic rethink is needed on the kind of materials used for construction if the construction and demolition wastes are to be recycled in an eco-friendly manner.

Bamboo the emerging hero

The construction industry was looking for a structural material that is strong, durable, natural and recyclable. This is where the humble bamboo comes in. There are over 1,500 species of the bamboo that grow in virtually every kind of climate on earth. Out of these a few giant species belonging to the Dendrocalamus genus have the right size, strength, hardness and flexibility to be used in the construction industry as a substitute for steel (Goh et al, 2019). This is a renewable grass variety which grows very fast, uses very little natural resources, can grow in degraded soils well and serves to create good, lasting construction, especially in rural areas.Bamboo has been traditionally used for construction in many south and south eastern countries to make houses, some of which are even earthquake resistant. These involve a very lightweight frame that is easy and quick to put together into any construction. Bamboo has a strength on par with steel and density that is one sixth that of steel, giving a very light weight powerhouse for construction. This also results in another popular construction related use, the scaffolding. Considering south and south east asia, India has the largest area under bamboo accounting for 54.9% of the total bamboo cultivated areas when compared to other countries as at 2005. Though a large area does come under bamboo growth, construction specific bamboo is not much studied. And each species of the Bamboo is used to serve a different application. Nine species are mentioned as construction worthy, namely Bambusa Oldhamii, Bambusa Lako, Dendrocalamus Asper, Dendrocalamus Brandisii, Dendrocalamus Yunnanicus, Gigantochloa Apus, Gigantochloa Atter and Gigantochloa Pseudoarundinacea.

Bamboo cannot be used for construction without proper treatment as it is susceptible to fungal attack and rot. Seytiyowati and Mappaturi (2020) mention both natural and chemical treatment

methods to extend the shelf life for bamboo construction structures. Chin (2021) talks of bamboo as a replacement for concrete itself.

Bamboo in construction can be used in foundation, roofing with bamboo tiles, trusses in large buildings, walls, doors, windows, water piping, flooring and ceilings. Due to its lightweight, a 1,00 foot scaffolding can be put together within a day (Goh et al, 2019). They also note that the energy to produce steel is around 234,000 kg/cu m and concrete is 1920 kg/cu m while that of bamboo is just 300 kg/cu m.

Bamboo however, to last long needs to be rid of the sugar and carbohydrates that it has and also the moisture it contains. Traditional methods for achieving this involve soaking, smoking, clump curing, white washing and plastering. Chemical treatment involves use of Boron, borax and boric acid These are safe and eco friendly chemicals that preserve the bamboo poles for a long time. (Goh et al, 2019)

Some hybrid models use bamboo instead of steel to reinforce concrete. The resultant structure is just as durable as the concrete reinforced with steel. (Kumar et al, 2021). This still reduces the energy needed to make steel, which means the freed up energy could be used for other purposes.

Bamboo composites can be used in any kind of building. (Yadav and Mathur, 2021). Developing countries have a greater use for bamboo as a construction material. They mostly combine bamboo with other materials like mud to build their houses. This has given bamboo the nickname - Poor man's timber. (Atamewan, 2020). It is also possible to build a multi level bamboo house that is also long lasting. (Kordea et al, 2018)

Added to this Bamboo also absorbs maximum carbon dioxide and releases more oxygen than comparable size trees. It also improves soil structure and provides both green and dry fodder to animals as well. Hence both during growth and after harvest as well, the humble bamboo is working towards a sustainable environment (Ramakrishnan et al, 2018). This leads us to propose the following

H3: Bamboo is a well worthy replacement for steel in the construction industry. It can also do away with cement if an appropriate binder is used.

Costs and Farming Income

Bamboo construction costs just a fraction of what a conventional steel and cement structure would cost and yet maintains the same durability (Harison et al, 2017). Prefabricated panels for walls and other structures made using bamboo are also equally durable and super light for construction (Puri et al, 2017). In addition to providing low cost building materials for the construction sector, especially the rural ones, bamboo is also a source of livelihood for rural

folk, as this plant grows even in degraded and sandy soil conditions. This has a direct impact on the GDP of the nation and also opens up a low cost option to develop wastelands with nation building materials (Manandhar et al, 2019). In earthquake prone areas a traditional bamboo housing called wattle and daub has been used for ages, and these structures have withstood earthquakes for many hundreds of years. This has inspired the modern mind to use the bamboo concept to create earthquake proof housing. (Vengala and Rao, 2020). This leads us to the following hypothesis

H4: Bamboo provides the twin benefits of a good renewable construction material and rural economy booster benefits

Conclusion

The construction industry, which is usually the biggest industry in any economy, is also usually the most unsustainable, with hardly any regulation on which resource it impacts, which habitat it pollutes and which landfill it goes to after it is demolished. Added to this it consumes the maximum energy and water resources available and is rarely audited for sustainability. This necessitates the need for an alternate sustainable, renewable and cheap building material. Bamboo fits the billing perfectly and also serves to improve rural prosperity and water conservation initiatives in one stroke.

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